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Historical Development: Hermes Satellite

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Hermes Satellite

Communications Technology Satellite (CTS)

Introduction

In the early 1960's, international communication satellites using the 6/4 GHz bands and positioned in the geostationary satellite orbit were found to be capable of providing high quality telecommunications services. Domestic satellite communications systems were planned and were implemented, beginning in 1972, with the Telesat Canada ANIK-A System.

Projections of the growth of international and domestic systems indicated that the 6/4 GHz bands in the geostationary orbit would soon become crowded. Additionally, the sharing of the 6/4 GHz bands between terrestrial and satellite fixed services placed major constraints on the location of satellite ground terminals. Portions of the spectrum at 14/12 GHz had been allocated for satellite communications without a flux density limit providing an opportunity for development of new services, including satellite broadcasting. However, the communication system designers required more complete information on the characteristics of operation at the higher frequency bands.

Although the former Canadian Department of Communications (DOC), in particular the Communications Research Centre (CRC), now an agency of Industry Canada, did not have an operational role, it had an objective to foster the development of telecommunications services for the benefit of the people of Canada and to ensure that Canadian companies participated to the maximum extent possible in the development and production of the necessary hardware.

The Communications Research Centre in Ottawa formerly part of DOC

In 1971, the DOC/CRC and the U.S. National Aeronautics and Space Administration (NASA) signed a Memorandum of Understanding to develop and launch the experimental Communications Technology Satellite (CTS) and to share its use to conduct satellite communications experiments using the 14 and 12 GHz bands and low cost transportable ground terminals.

Artist's concept of the Hermes spacecraft

The Communications Technology Satellite, named Hermes in January 1976, after the Greek god of science and eloquence, was the first satellite to operate at 14/12 GHz. It was used for 3-3/4 years by Canada and the USA to conduct experiments in new telecommunications services and technology.

In Canada, 37 different experiments were conducted by federal, provincial and private agencies and organizations in cooperation with the Department of Communications in areas of telemedicine, tele-education, community communications, administrative services, TV distribution and to explore the technology required for operation at 14/12 GHz. A family of 27 ground terminals were loaned to experimenters.

The major experiments and the spacecraft performance were tested to indicate the capabilities of the 14/12 GHz communications system and the flexibility of satellite communications to meet new service needs. Among these was a particularly significant experiment to evaluate the performance of low-cost TV Receive Only (TVRO) terminals in isolated and difficult environments.

One of the more promising applications of the satellite technology was the capability to receive signals at private homes directly from satellite by means of consumer oriented television receive only terminals. The development of these terminals and the experience gained through experimentation on Hermes was the prelude to the direct broadcast services (DBS) now available worldwide.

In July 1979, the Hermes satellite was moved from 116∞W longitude to 142∞W to permit trials of 14/12 GHz satellite communications to be conducted in Australia. The trials addressed the needs of outback locations as an example of broadcasting applications.

The Hermes Satellite

Under the agreement with NASA, Canada designed and built the spacecraft. NASA provided an experimental 200W traveling-wave-tube amplifier (TWTA) and environmental test support. In 1972, DOC/CRC signed an agreement with the European Space Agency (ESA), under which ESA agreed to provide 20W TWTAs, a SHF parametric amplifier and to develop the solar blanket.

NASA provided the launch vehicle, launch and operational support to place the spacecraft in the geostationary satellite orbit. Following the handover from NASA to DOC/CRC of the satellite in orbit at 116∞W longitude, DOC/CRC configured the satellite for its operational mission, and operated the satellite for U.S. and Canadian communications and spacecraft technology experiments.

The Hermes satellite was completed assembled, integrated and tested in the David Florida Lab located at CRC. Canadian companies manufactured the entire ground segment that was used for the Canadian trials.

The principal technological objectives of the program were to develop and flight test:

1. a power amplifier tube having greater than 50% efficiency with a saturated power output of 200W at 12 GHz;
2. a light-weight extendible solar array with an initial power output greater than 1 kW;
3. a 3-axis stabilization system to maintain accurate antenna boresight positioning on a spacecraft with flexible appendages;
4. Conduct satellite communications systems experiments using the 12 and 14 GHz bands and low cost transportable ground terminals.

The Program

The major Canadian objectives of the Hermes Communications satellite program were:

- To enhance in Canada a capability for the design and manufacture of spacecraft subsystems for domestic use and for export.
- To maintain a Canadian capability to specify, assess and construct space application systems for domestic use.
- To develop and flight test spacecraft subsystems and components for use in future communications satellites.

- To advance the technology for space and ground components of satellite systems that use high-radiated radio frequency power.
- To conduct communications experiments to explore the use of future high-power communications satellites in Canada, to low cost ground stations in the 14- and 12-GHz bands.
- To explore by means of communications experiments the social, cultural and economic impact of the eventual introduction of new services.

The transponder design allowed several types of experiments to be carried out, including:

- TV broadcast to small communities in remote areas;
- TV transmission, using a transportable terminal, of special events from a remote region to a central area for network distribution or for retransmission to other remote regions.
- Broadcast of radio program material to small earth stations;
- Telephone service including voice, facsimile and data, to and between small transportable earth stations;
- Digital data transmission and exchange;
- Investigation of high-speed satellite data transmission;
- Investigation of time division multiple access (TDMA) techniques.

Conclusions

The development of the Hermes satellite and its use in a significant program of experiments had a major impact in proving the suitability of the 14/12 GHz band for satellite communications and broadcasting. The experiments showed that precipitation attenuation is essentially as predicted but attenuation that occurs during very heavy rainfall is of limited duration. The technology of the ground terminals at 14/12 GHz proved to be no more difficult than at 6/4 GHz and the higher pointing accuracies required were not difficult to achieve. Demonstration of major advantages were possible because of the lack of a power flux density limit and freedom from the need to coordinate with terrestrial services. This permitted location of earth stations at customers' premises to meet specialized needs without the cost and complexity of terrestrial links. Hence, the inherent flexibility of satellite communications and capability for rapid implementation of a new service over a wide area was fully exploited.

The experimental nature of the Hermes satellite, the time sharing with the U.S.A. and the large number of Canadian experiments conducted limited the extent to which the need for a new service and its economic could be evaluated. The need to explore further the potential of the successful Hermes services led the DOC/CRC to enter into an agreement with Telesat Canada to lease 14/12 GHz transponders on the ANIK-B satellite, which also carried 6/4 GHz transponders to replace the aging ANIK-A satellites in service.

For further information see the following links and references:

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